

Original Research Article

A prospective study of surgical site infections in a tertiary care hospital

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ABSTRACT

Background: Among the Health care associated infections (HAI), surgical site infections (SSI) previously termed as post-operative wound infections are one of the most common HAI in low and middle income countries. Increase in SSI is associated with increased morbidity, as well as mortality due to emergence of antimicrobial resistant pathogens. Understanding the pathogens implicated in causing the SSIs and their antimicrobial sensitivity place a good role in reducing the mortality and morbidity.

Methods: A prospective study was conducted at a tertiary care hospital to all the patients admitted in Department of surgery, Orthopedics and Gynecology and Obstetrics for six months from January 2016 to June 2016. The demographic data, inclusion criteria and exclusion criteria, risk factors, clinical history, laboratory data with gram stain, culture results and antibiotic sensitivity of the isolates were collected.

Results: Two hundred patients were recruited in the study and the prevalence of SSI in the study was 3.83%. Patients who underwent emergency operations and diabetics were at higher risk of acquiring SSI. The most commonly isolated pathogens in the study were *Staphylococcus aureus*, *Escherichia coli*, and *Pseudomonas aeruginosa*. *Pseudomonas aeruginosa* was most common isolate from orthopedic cases of SSI, *Escherichia coli* was most common isolate from intestinal surgeries and *Staphylococcus aureus* from LSCS. Increased rate of isolation of MRSA and ESBL strains were observed in the study.

Conclusions: Study clearly explains the various causes and risk factors associated in development of SSI. The study guides in the type of the organism isolated and possible antibiotic of choice in treatment and management of SSI. The prevalence of SSI was 3.83%, which is comparable with some of the studies and lower than many of the studies.

Keywords: ESBL, MRSA, *Pseudomonas aeruginosa*, Surgical site infections

INTRODUCTION

Among the Health care associated infections (HAI), surgical site infections (SSI) previously termed as post-operative wound infections are one of the most common HAI in low and middle income countries. The prevalence of these infections varies widely ranging from 5-16%. In India, based upon the various studies prevalence of SSI varies between 5% and 24%.¹ SSI are defined as an infection occurring within 30 days after a surgical

operation (or within 1 year if an implant is left in place after procedure) and affecting either incision or deep tissues at the operation site.² Despite advances in SSI control practices, like improved operating room ventilation, sterilization methods, use of barriers, surgical technique there has been an alarming rise in low and middle income countries. Increase in SSI is associated with increased morbidity, as well as mortality due to emergence of antimicrobial resistant pathogens. Factors related to development of SSI include patient related factors like smoking, diabetes etc. and also operation

related factors like duration of surgery, type of surgery etc.³ Thus the identification of these factors that cause and predict these infections continues to be an area of research. There are various strategies to minimize the SSIs, and these can be interventions done before, during or after surgery.⁴ Understanding the pathogens implicated in causing the SSIs and their antimicrobial sensitivity place a good role in reducing the mortality and morbidity. Studies have shown an increase in the trend of SSIs attributable to antimicrobial resistant pathogens such as MRSA. The present study was undertaken with an aim to identify the possible risk factors related to development of SSIs and the common pathogens encountered in development of SSIs. Identifying the pathogens and their antimicrobial sensitivity provides help in empirical management of SSIs.

METHODS

A prospective cross sectional study was conducted at Narayana Medical College and Hospital by Department of General Surgery in association with Department of Microbiology for a period of Six months from January 2016 to June 2016. The study was carried out at General surgery wards, Obstetrics and Gynecology wards, orthopedics wards. All the cases that were identified with SSI were included in the study. The study was approved by the institutional ethical committee of the college and all the procedures were conducted in accordance to ethical guidelines.

Inclusion criteria

All the age groups excluding the children <5 years, confirmed cases of SSI (As per case definition) and who consented for the study.

Exclusion criteria

Infection occurring 30 days after the surgery, infection of episiotomy, donor sites of split skin grafts and refusal to give consent for participating in the study.

Case definition of SSI

Defined as per CDC Guidelines: SSI was classified as superficial, deep incisional or organ/space infection with

- Purulent drainage with or without laboratory confirmation from the superficial or deep incision
- Organism isolated from an aseptically obtained culture of fluid or tissue from superficial or deep incision or organ/space
- Sign or symptoms of infection: Pain and tenderness, localized swelling, or heat
- Purulent drainage from the drain that is placed into the organ/space
- Diagnosis of SSI by surgeon or attending physician.⁵

200 patients were recruited in the study and all the patients fulfilled the inclusion criteria. A structured questionnaire form consisting of demographic data, risk factors, past medical history, antibiotic usage history, and particulars of surgery, antibiotic prophylaxis was noted. Swabs were collected from the infected site as per standard guidelines, and collected before dressing was done. Swabs were transported immediately to the Central Microbiology Laboratory and processed immediately as per standard CLSI guidelines. The pathogens were isolated and identified by a battery of biochemical tests and antimicrobial susceptibility of the pathogen was performed as per CLSI Guidelines.⁶

For gram positive organisms susceptibility was tested against penicillin (10 unit), ampicillin (10µg), amoxicillin/clavulanate (20/10µg), ceftriaxone (30µg), vancomycin (30µg), gentamycin (10µg), erythromycin (15µg), tetracycline (30µg), ciprofloxacin (5µg), clindamycin (2µg), trimethoprim/sulfamethaxazole (1.25/23.75µg) chloramphenicol (30µg), and Linezolid(30µg). Gram negative organisms were tested against ampicillin (10µg), amoxicillin/clavulanate (20/10µg), ceftriaxone (30µg), ceftazidime (30µg), cefotaxime (30µg) gentamycin (10µg), tetracycline (30µg), ciprofloxacin (5µg), trimethoprim/sulfamethaxazole (1.25/23.75µg), chloramphenicol (30µg), imipenem (10µg) and Meropenem (10 µg) Methicillin resistance *Staphylococcus aureus* was determined by disc diffusion test using cefoxitin (30µg) disc and results were interpreted as per CLSI guidelines. Inducible clindamycin resistance was detected among *Staphylococcus aureus* by disc diffusion test using erythromycin (15µg) and 2µg of Clindamycin placed on Muller Hinton agar and observing the D-Zone as per CLSI guidelines. ESBL strains of gram negative organisms were detected by screening by using ceftazidime (30µg) or ceftaxime (30µg) disc on Muller Hinton agar and confirmed by double disc synergy test. Results were entered in a separate excel sheet and data was captured. *Escherichia coli* ATCC 25922, *Klebsiella pneumoniae* ATCC 700603 for ESBL, *S. aureus* ATCC 25923, and *S.aureus* ATCC 29213 for MRSA were used as control strains.

Statistical analysis

Data was entered in Microsoft excel spread sheet and analyzed. Frequency distribution and two way tables were used to summarize the data and Chi-square test or Fishers Exact Test were used to determine the association between independent and dependent variables, p values of < 0.05 were considered significant.

RESULTS

The present study at Narayana medical college and hospital was done for a period of 6 months. During the study period a total of 5210 surgeries were conducted and 200 defined cases of SSI as per CDC guidelines were

enrolled in the study. The number of surgeries and the type of surgery in each department and percentage of cases infected are presented in Table 1.

Table 1: Surgical procedures and rate of SSI.

| Type of Surgery | Number done | Number infected | % |
|------------------------|-------------|-----------------|------|
| LSCS | 845 | 48 | 5.7 |
| Orthopedic procedures | 984 | 38 | 3.9 |
| External fixation | 546 | 22 | 4.02 |
| Internal fixation | 274 | 8 | 3 |
| Amputation | 164 | 8 | 4.9 |
| Intestinal surgeries | 744 | 44 | 6 |
| Small intestine | 248 | 20 | 8 |
| Large intestine | 328 | 12 | 3.6 |
| Appendicectomy | 168 | 12 | 7.1 |
| Gynaecological surgery | 162 | 10 | 6.17 |
| Hysterectomy | 138 | 7 | 5 |
| Uterine prolapse | 24 | 3 | 12.5 |
| Hernia | 202 | 34 | 16.8 |
| Surgical debridement | 315 | 26 | 8.25 |
| Others | 68 | 10 | 14.7 |
| Total | 5210 | 200 | 3.83 |

Others: Thyroidectomy, Breast surgery, Fistula repair, Lumpectomy, Incision and drainage.

Overall prevalence of SSI in the present study was 3.83%. 41.18% were from the general surgery ward, 32.58% from orthopedics unit and 26.24% from the obstetrics and Gynecology ward. Major prevalence of SSI was observed in cases of Hernia repair (16.8%) and least was noted among cases that underwent orthopedic procedures (3.9%). Majority of the patients were in the age group of 18-26 years with range from 16-83 years, mean (SD) of 34.5±14.2 years and median 34 years. Of the 200 patients in the study group, 61% were males and 39% were females. 56% of cases underwent emergency surgery and 44% were elective procedures.

The rate of SSI was more in contaminated operations (39%) compared to clean operations (32%), clean contaminated (19%) and dirty operations (10%). Based on the case record and answer from the cases, 74% had history of hospitalization < 6 months, 62% had history of antibiotic prophylaxis <1 month and 34% of cases were non-diabetic and 39% of cases were having uncontrolled diabetes and 27% controlled diabetics (Table 2).

Table 3 shows the correlation between gram stain and culture results. Out of 200 swabs collected, pus cells were observed in 91.3% (168/182) of cases with bacterial growth and among 16 cases where bacterial growth was not observed. In only 2 cases pus cells were absent and bacterial growth was absent. Statistically significant association was observed between presence of pus cells and bacterial growth (p value<0.05). Bacteria were observed by gram stain in 93.6% (176/182) cases with

growth positivity and in 12 cases growth was absent even observed by microscopy. These may be due to dead bacteria or presence of anaerobic organisms which were not cultivated on routine media. In 6 cases bacteria as well as growth was absent.

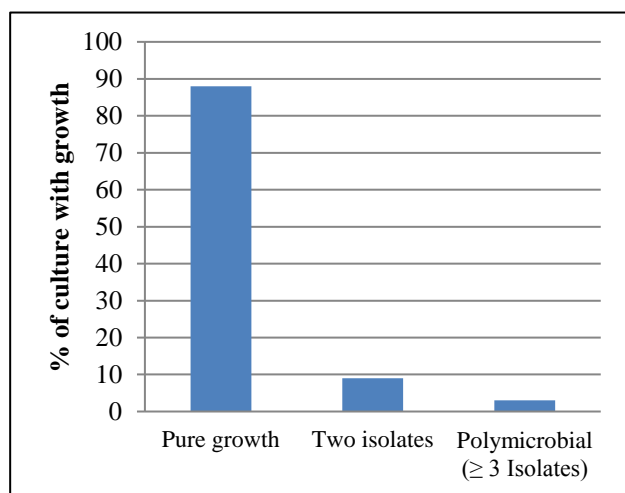
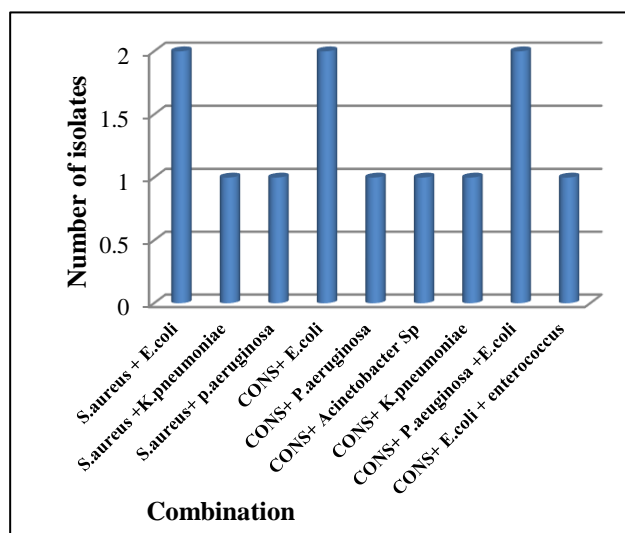
Table 2: Demographic and clinical characteristics of patients with SSI.

| Variables | No | % |
|---|-------|------|
| Age (years) | | |
| Median | 34 | |
| Mean (SD) | 34.5 | 14.2 |
| Range | 16-83 | |
| Sex | | |
| Male | 122 | 61 |
| Female | 78 | 39 |
| Surgical department | | |
| General surgery | 104 | 52 |
| Obstetrics/ gynecology | 58 | 29 |
| Orthopedics | 38 | 19 |
| Type of Surgery | | |
| Elective | 88 | 44 |
| Emergency | 112 | 56 |
| Type of operation | | |
| Clean | 20 | 10 |
| Clean contaminated | 38 | 19 |
| Contaminated | 78 | 39 |
| Dirty | 64 | 32 |
| Operative procedure | | |
| Caesarian section | 48 | 24 |
| Laparotomy | 78 | 39 |
| External fixation | 22 | 11 |
| Internal fixation | 8 | 4 |
| Amputation | 8 | 4 |
| Surgical debridement | 26 | 13 |
| Others | 10 | 5 |
| H/O Hospitalization | | |
| Yes | 148 | 74 |
| No | 52 | 26 |
| H/O Antibiotic prophylaxis (1 month) | | |
| Yes | 124 | 62 |
| No | 76 | 38 |
| H/o Diabetes | | |
| Controlled diabetic | 54 | 27 |
| Uncontrolled diabetic | 78 | 39 |
| Non-diabetic | 68 | 34 |

Figure 1 illustrates the number of isolates from the swabs collected. Out of 200 swabs collected and processed, 88% (160) had pure growth (Mono isolate), 9% (16) had two isolates from culture and 3% (6) had polymicrobial growth. (≥ 3 isolates from culture). In the present study, most of the pure isolates were from clean wounds and mixture was from contaminated and dirty wounds. Figure 2 exhibits the number and common combinations isolated.

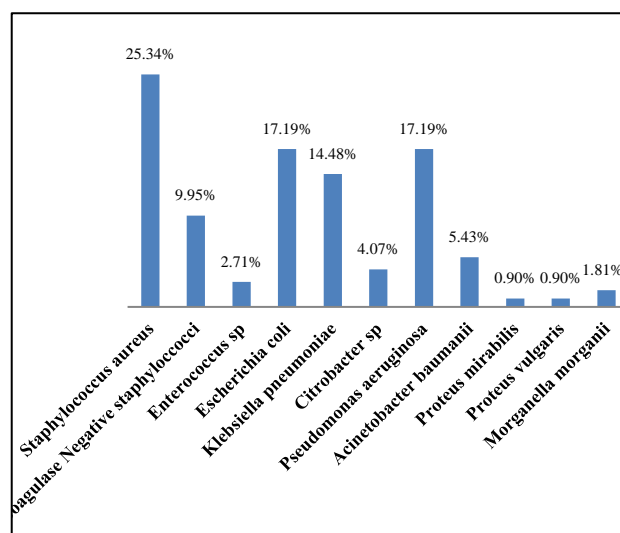
Table 3: Gram stain correlation with culture results.

| Gram stain morphology | Culture results | | |
|-----------------------|-----------------|---------------------|-------|
| | Growth positive | No bacterial growth | Total |
| Pus cell | | | |
| Seen | 168 (91.3%) | 16 (8.7%) | 184 |
| Not seen | 14 (87.5%) | 2 (12.5%) | 16 |
| Bacteria | | | |
| Present | 176 (93.6%) | 12 (6.4%) | 188 |
| Absent | 6 (50%) | 6 (50%) | 12 |

**Figure 1: Type of growth from swabs.****Figure 2: Polymicrobial combinations isolated.**

Out of 200 swabs collected 182 (91%) yielded positive growth with a total 221 aerobic isolates. Gram positive isolates were 84/221 (38%) and gram negative isolates were 137/221 (62%) and predominant. *Staphylococcus aureus* was the predominant isolate among all (25.34%) followed by *Escherichia coli* and *Pseudomonas aeruginosa* (17.19%). Figure 3 summarizes the various isolates from the cases of SSI.

Bacterial isolation rates were higher among general surgery cases (41.18%) when compared to orthopedics unit (32.58%) and gynecology-obstetrics cases (26.24%). These differences were not statistically significant. *Klebsiella pneumoniae* was the commonest isolate from surgical cases (26.37%) followed by *Escherichia coli* (24.18%) and *Staphylococcus aureus* (17.58%). *Pseudomonas aeruginosa* (36.11%) was the commonest isolate from orthopedics cases followed by *Staphylococcus aureus* (27.78%). *Staphylococcus aureus* (34.48%) was the commonest from Gynecology-obstetrics cases followed by *Escherichia coli* (25.86%). Table 4 shows the frequency of bacterial isolates in relation to the type of operation. Majority of the isolates (57/221) were from orthopedic procedures followed by LSCS (48/221) and intestinal surgeries (45/221). Of note to observe *Escherichia coli* was the commonest isolate from intestinal surgeries.

**Figure 3: Organisms isolated from SSI.**

Antibiotic susceptibility of Isolates

Out of 56 strains of *Staphylococcus aureus*, 20 were resistant to cefoxitin and confirmed as MRSA. All the strains were resistant to penicillin (100%) and >90% of strains were resistant to Ampicillin, Chloramphenicol and Cotrimoxazole. Resistance to vancomycin and linezolid was not identified in the study even in MRSA stains. 4 isolates exhibited inducible clindamycin resistance and 2 of them were also MRSA.

Similar pattern of resistance and sensitivity was noted among Coagulase negative staphylococci. *Enterococcus* exhibited 100% resistance to penicillin and Ampicillin in the study. None of the isolates were resistant to vancomycin (Table 5).

All the gram-negative isolates in the study exhibited maximum sensitivity to Carbapenems (Imipenem, Meropenem), piperacillin + tazobactam and 3rd and 4th generation cephalosporins (Ceftriaxone, Ceftazidime).

Lesser degree of sensitivity was noted to Ampicillin, Amoxy-clavulanic acid, gentamycin, Co-trimoxazole and ciprofloxacin. ESBL production was demonstrated in *E. coli*, *Klebsiella pneumoniae*, *Citrobacter sp*, *Pseudomonas aeruginosa* and *Acinetobacter sp*. 5 strains of *E. coli* resistant to cefotaxime were tested for ESBL production by Double disc Synergy test and all tested were ESBL producing. Only 2 strains of *K. pneumoniae* were ESBL producing, six strains of *P. aeruginosa* were ESBL producing and among *Acinetobacter sp* 3 strains were ESBL producers and one strain of *Citrobacter sp*. (Table 6) (Figure 4).

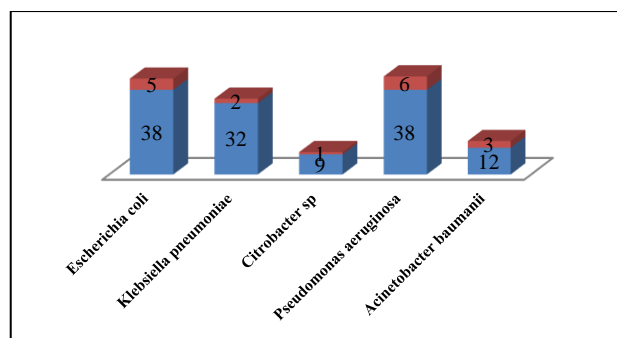


Figure 4: ESBL positive isolates.

Table 4: Number of bacterial isolates in relation to type of operation.

| Organism isolated | LSCS (no) | Orthopedic procedures (no) | Intestinal surgeries (no) | Gynaecological surgery (no) | Hernia (no) | Amputation (no) | Others (no) | Total |
|---|-----------|----------------------------|---------------------------|-----------------------------|-------------|-----------------|-------------|-------|
| <i>Staphylococcus aureus</i> | 16 | 18 | 6 | 4 | 4 | 2 | 6 | 56 |
| <i>Coagulase negative staphylococci</i> | 10 | 6 | 2 | | 4 | | | 22 |
| <i>Enterococcus sp</i> | 1 | | 1 | | 4 | | | 6 |
| <i>Escherichia coli</i> | 11 | | 18 | 4 | 4 | 1 | | 38 |
| <i>Klebsiella pneumoniae</i> | 4 | 1 | 12 | 2 | 10 | 1 | 2 | 32 |
| <i>Citrobacter sp</i> | 2 | 4 | 1 | | | | 2 | 9 |
| <i>Pseudomonas aeruginosa</i> | 2 | 18 | 2 | | 8 | 8 | | 38 |
| <i>Acinetobacter baumannii</i> | 1 | 8 | 1 | | | 2 | | 12 |
| <i>Proteus mirabilis</i> | 0 | | 1 | | | 1 | | 2 |
| <i>Proteus vulgaris</i> | 0 | 2 | | | | | | 2 |
| <i>Morganella morganii</i> | 1 | | 1 | | | | 2 | 4 |
| Total | 48 | 57 | 45 | 10 | 34 | 15 | 12 | 221 |

Table 5: Antibiotic resistance pattern of gram positive isolates.

| | S.aureus (%) | MRSA (%) | CONS (%) | <i>Enterococcus</i> (%) |
|-----------------|--------------|----------|----------|-------------------------|
| Gentamycin | 21.43 | 20 | 54.55 | 33.33 |
| Ceftriaxone | 28.57 | 30 | 36.36 | 33.33 |
| Ciprofloxacin | 50.00 | 30 | 40.91 | 33.33 |
| Ampicillin | 96.43 | NT | 100.00 | 100.00 |
| Amoxy/clav | 50.00 | NT | 72.73 | 66.67 |
| Cotrimoxazole | 92.86 | 40 | 90.91 | NT |
| Chloramphenicol | 92.86 | 40 | 81.82 | NT |
| Tetracycline | 85.71 | 50 | 81.82 | NT |
| Penicillin | 100.00 | NT | 100.00 | 100 |
| Cefoxitin | 35.71 | NT | NT | NT |
| Clindamycin | 7.14 | NT | 0 | NT |
| Oxacillin | 35.71 | NT | 45.45 | NT |
| Erythromycin | 67.86 | 40 | 40.91 | 66.67 |
| vancomycin | 0.00 | 0 | 0 | 0 |
| Linezolid | 0.00 | 0 | 0 | 0 |

Table 6: Antibiotic sensitivity pattern of gram negative bacterial isolates.

| | <i>E. coli</i> (%) | <i>K.pneumoniae</i> (%) | <i>Citrobacter sp</i> (%) | <i>P.aeruginosa</i> (%) | <i>A.baumannii</i> (%) | <i>P.mirabilis</i> (%) | <i>P.vulgari</i> s (%) | <i>M.morganii</i> (%) |
|--|-----------------------|----------------------------|------------------------------|----------------------------|---------------------------|---------------------------|---------------------------|--------------------------|
| Gentamycin | 57.9 | 87.5 | 77.8 | 71.1 | 50 | 100 | 100 | 100 |
| Amikacin | 84.2 | 87.5 | 77.8 | 84.2 | 66.7 | 100 | 100 | 100 |
| Ceftriaxone | 84.2 | 87.5 | 88.9 | 76.3 | 75 | 100 | 100 | 100 |
| Ciprofloxacin | 63.2 | 75.0 | 88.9 | 47.4 | 41.7 | 50 | 50 | 50 |
| Ampicillin | 15.8 | 18.8 | 22.2 | NT | NT | NT | NT | NT |
| Ampicillin+ Clavulanic 55 acid | 57.9 | 75.0 | 55.6 | NT | NT | NT | NT | NT |
| Sulphomethoxa zole/ Trimethoprim | 36.8 | 31.3 | 55.6 | NT | NT | NT | NT | NT |
| Piperacillin+ta zobactam | 89.5 | 100.0 | 88.9 | 97.4 | 83.3 | 100 | 100 | 100 |
| Cefotaxime | 86.8 | 93.8 | 88.9 | 84.2 | 75 | 100 | 100 | 100 |
| Ceftazidime | 78.9 | 93.8 | 88.9 | 89.5 | 75 | 100 | 100 | 100 |
| Imipenem | 94.7 | 96.9 | 100.0 | 92.1 | 100 | 100 | 50 | 100 |
| Meropenem | 94.7 | 96.9 | 100.0 | 92.1 | 100 | 100 | 100 | 100 |

DISCUSSION

In the present study conducted in a teaching hospital, the incidence of SSI was 3.83%. SSI in the present study was defined as per CDC guidelines. However, the incidence of SSI is influenced by various operation related factors (type of operation performed, nature of operation, Anesthesia type etc.), physical factors and patient related factors (age of patient, sex of patient, co morbidities etc.) etc. The incidence in our study was on par with findings of Murthy R et al who reported 4.2% as incidence of SSI in their study, 7 but very low when compared to study done in Georgia who reported the overall incidence as 16.7%. 8 This variation can be explained by different factors involved in the study analysis like place of study, type of operation etc. In our study, males were predominant (61%) than females indicating more number of surgeries was done on males than females. These findings were on par with findings of Tanner J et al The rate of SSI was more in males than females in our study.⁹

The common age group in the study was 18-26 years followed by 46-55 years which is on par with the findings of Khairy GA et al but contrary to findings of Astagneau Leaper et al who reported SSI more in age group >65 years.^{10,11} The rate of SSI were higher in emergency surgeries than elective procedures as described by many other studies also (56% versus 44%).^{12,13} This can be due to the reason like emergency surgeries lack regular pre-operative preparation and involve mostly abdominal and intestinal surgeries which are contaminated surgeries. As reported in many studies, rate of SSI was higher among uncontrolled diabetics than controlled and non-diabetics in our study. This observation was on par with findings of Neumayer et al.¹⁴

As reported from this study, SSI was higher in cases of abdominal surgeries (Hernia and Intestinal surgeries) than in other surgeries. Others also observed the same findings in their studies. The rate of SSI was higher in contaminated surgeries followed in order by dirty, clean contaminated and clean surgeries. Similar findings were reported in the findings of Rosentha et al in his study.¹⁵

In the present study, the commonest bacterial isolate was staphylococcus aureus (25.34%) from various SSI which coincides with the findings of Kownhar H who reported the 37% of isolates as S.aureus among which 27% were MRSA.¹⁶ Majority of S.aureus was isolated from cases of orthopaedic SSI and procedure was open fractures with fixation followed by LSCS surgeries among who underwent emergency procedure. These findings were on par with findings of Burns TC et al.¹⁷ However, the incidence of MRSA was significantly higher in our study (37%) when compared with the findings of Burns TC et al, Kamat U et al.¹⁸ Various other studies have reported *Pseudomonas aeruginosa* and *Escherichia coli* as major isolates in their studies. However, the type of isolate is dependable upon variable physical and operational factors (Type of operation etc.). Coagulase negative *Staphylococcus* was the major isolate recovered from cases of SSI following LSCS.

In present study among Gram negative isolates, *Escherichia coli* and *Pseudomonas aeruginosa* were predominant isolates as per findings of many studies. *E.coli* was the major isolate from intestinal surgeries and abdominal surgeries as mentioned in the study of Suljagic V et al.¹⁹ Regarding the frequency of isolation of organisms from different surgical units, *E.coli* and *Klebsiella pneumoniae* were common from surgical wards and *Pseudomonas aeruginosa* from orthopaedic

wards. These observations were similar to findings of Bericon et al and Anvikar et al.^{20,21}

In the present study, *S.aureus* was highly resistant to penicillin and ampicillin which concurs with many of the studies reported recently.^{22,23} A notifiable finding in our study was a greater proportion of *S.aureus* strains, exhibited resistance to Amoxycyclanic acid which indicates a gradual decline in the use of this drug for treatment of SSI caused by *S.aureus*. The current study documented a higher rate of methicillin resistance among *S.aureus* (37%), which signifies the increasing trend of MRSA infection and wide spread reports locally and globally confirms the findings of our study. Resistance was not observed to vancomycin and linezolid in our study.

CONS were isolated and all the strains in the study were resistant to penicillin and ampicillin. None were resistant to vancomycin and linezolid. Similar findings were observed in the reports of Cantlon CA et al who reported CONS as a major isolate from SSI.²⁴ Few of the strains of *S.aureus* exhibited Clindamycin resistance which suggests a thorough screening of isolates in treatment of Staphylococcal infections.

In this study, gram negative isolates exhibited maximum degree of resistance to commonly used low generation antibiotics and these findings were in consistent with many other studies globally. The reason is these antibiotics are widely prescribed in empirical treatment of various infections in our setting. So, usage of these drugs in treatment of SSI should be monitored and switched over to other drugs in non-responsive cases. Most of the isolates in the study exhibited greater degree of resistance to Amoxycyclavulanic acid than expected and this signifies a gradual shift of organisms towards antibiotic choice. Most of the gram-negative isolates were multi drug resistant and exhibited maximum sensitivity to carbapenems and Piepracillin/tazobactam. Moderate degree of sensitivity was noted to higher generation cephalosporins by *Pseudomonas aeruginosa* and 100% sensitivity by *Proteus sp.* These findings suggest usage of higher generation cephalosporins and carbapenems as a primary choice of antibiotics in treatment of SSI. All the resistant gram negative isolates were tested for ESBL production and significant increase in the numbers were noted as compared previous studies in the hospital.²⁵ Carbapenem resistant strains were observed only in *Escherichia coli*, *Klebsiella pneumoniae* and *Pseudomonas aeruginosa* and most of the strains were ESBL producers. Most of the studies document an increasing trend of ESBL production among this isolates.²⁶

CONCLUSION

Study clearly explains the various causes and risk factors associated in development of SSI. The study guides in the type of the organism isolated and possible antibiotic of

choice in treatment and management of SSI. The prevalence of SSI was 3.83%, which is comparable with some of the studies and lower than many of the studies. *E.coli* was the commonest isolate from intestinal surgeries and *Pseudomonas aeruginosa* from orthopedic surgeries. The rate of SSI was more in emergency operations and also in dirty wound than clean wounds.

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Conflict of interest: None declared

Ethical approval: The study was approved by the institutional ethics committee

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